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The emergency medicine management of clavicle fractures

Mark Serpico, MD, Spencer Tomberg, MD, MA *

Department of Emergency Medicine, Denver Health Medical Center, 777 Bannock St., Denver, CO 80204, United States of America

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ABSTRACT

Background: Clavicle fractures are common. An emergency physician needs to understand the diagnostic classifications of clavicle fractures, have a plan for immobilization, identify associated injuries, understand the difference between treating pediatric and adult patients, and have an approach to multimodal pain control. It is also important to understand when expert orthopedic consultation or referral is indicated.

Objective of the Review: To provide an evidence-based review of clavicle fracture management in the emergency department.

Discussion: Clavicle fractures account for up to 4% of all fractures evaluated in the emergency department. They can be separated into midshaft, distal, and proximal fractures. They are also classified in terms of their degree of displacement, comminution and shortening. Emergent referral is indicated for open fractures, posteriorly displaced proximal fractures, and those with emergent associated injuries. Urgent referral is warranted for fractures with greater than 100% displacement, fractures with >2 cm of shortening, comminuted fractures, unstable distal fractures, and floating shoulder. Nondisplaced or minimally displaced fractures with no instability or associated neurovascular injury are managed non-operatively with a sling. Pediatric fractures are generally managed conservatively, with adolescents older than 9 years-old for girls and 12 years-old for boys being treated using algorithms that are similar to adults.

Conclusions: When encountering a patient with a clavicle fracture in the emergency department the fracture pattern will help determine whether emergent consultation or urgent referral is indicated. Most patients can be discharged safely with sling immobilization and appropriate outpatient follow-up.

1. Introduction

Clavicle fractures are a common injury treated in the Emergency Department (ED). They are particularly common in children and young adults. Clavicle fractures account for up to 4% of all fractures seen in the ED, and 44% of fractures in the shoulder girdle [1,2,3]. A majority (87%) of clavicle fractures result from a fall onto the shoulder. A direct blow to the clavicle from an object (e.g. assault, projectile) or a fall onto an outstretched hand (FOOSH) are less common mechanisms [4]. Atraumatic clavicle fractures are rare. A Swedish epidemiological study of over 2000 clavicle fractures cited a rate of 0.7% due to a non-traumatic cause, most of which were pathologic fractures [5]. The highest rates of clavicle fractures in high school athletes occur in full contact sports (e.g. hockey, lacrosse, football, wrestling) and occur more frequently in boys than girls in gender-comparable sports [6].

Fractures of the middle third of the clavicle account for 70–80% of clavicle fractures [3,7]. Fractures of the distal (lateral) third are the second-most common clavicle fracture (17–25%) [2,3,5]. Proximal third clavicle fractures make up <5% of these injuries [8].

Nondisplaced clavicle fractures can be managed conservatively in almost all cases with good outcomes and return to full function [9,10,11,12]. Operative management of clavicle fractures has been shown to improve functional outcomes and to reduce the incidence of nonunion for properly selected patients [13,14,15,16,17]. Criteria for who should be considered for operative management are discussed in the following sections.

One of the overall goals of clavicle fracture management is to lower the risk of nonunion and symptomatic malunion, as they have been shown to lead to worse long-term patient-centered outcomes [1,16,18]. Nonunion is a radiographic finding in which there are no signs of fracture healing for three months. Smoking has been shown to increase the odds of nonunion by approximately four times. Comminution and fracture displacement have been shown to be independent risk factors for nonunion, with reported odds ratios (OR) ranging from 1.75–3.86 and 1.17–7.81 respectively [19,20]. A recent meta-analysis found that displaced midshaft clavicle fractures have a nonunion rate

* Corresponding author at: 2632 W 34th Ave, Denver, CO 80211, United States of America.
E-mail addresses: mark.serpico@denverem.org (M. Serpico), spencer.tomberg@denverem.org (S. Tomberg).

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of 16.5% when managed conservatively, whereas operative management reduces this rate to 1.4% [21]. Surgery shows similarly impressive reductions in nonunion rates for properly selected distal clavicle fractures [22], which are notorious for their high nonunion rate.

It is important for the emergency physician to develop an approach to managing clavicle fractures that correctly classifies the fracture and identifies which fractures may require surgical referral, in addition to providing adequate pain control and identifying associated injuries.

2. Methods

This article provides a focused review of the management of clavicle fractures for emergency providers. The authors searched PubMed to gather resources for the review using a combination of the following keywords: clavicle fracture, distal clavicle fracture, proximal clavicle fracture, pediatric clavicle fracture, proximal clavicle dislocation, and imaging of clavicle fractures. The search was conducted from inception until December 7, 2020. When specific information was required on a topic, additional searches of PubMed using keywords related to the question at hand were included. The search of the literature was limited to English language articles, and article selection focused on literature from emergency medicine and orthopedic specialties. There was significant overlap in the results of these searches. The authors prioritized articles that included information on both operative and nonoperative management and did not include articles that focused on discussion of specific techniques of operative management. The authors decided on article inclusion by consensus. Priority was placed on meta-analyses, randomized controlled trials and systematic reviews, and when additional information was required expert consensus, case reports, and retrospective studies were included. A total of 170 articles were included after the selection process.

3. Discussion

3.1. Anatomy

The clavicle is the only osseous link between the upper extremity and the trunk. It functions as a strut for the scapula and upper extremity to articulate on the thorax. It articulates distally with the acromion to form the acromioclavicular (AC) joint and proximally with the sternum to form the sternoclavicular (SC) joint. The clavicle is an "S" shaped bone with a greater medial curve and a lesser lateral curve. This curvature allows the clavicle to absorb stress but also gives it points of relative weakness. The middle third of the clavicle, given its location at the junction of these two curves, is the weakest portion of the bone and the most commonly fractured segment [23,24].

Vertical displacement of the clavicle is primarily prevented by the coracoclavicular (CC) ligaments. This complex consists of the trapezoid and conoid ligaments. The trapezoid is the more lateral of the two ligaments and attaches to the undersurface of the distal clavicle approximately 2 cm from the AC joint [25]. Anterior-posterior displacement of the clavicle is primarily prevented by the AC ligaments, which span the AC joint [26,27].

See Fig. 1. Clavicle anatomy and forces acting on the clavicle.

3.2. Classification

The Allman classification system describes the location of a fracture by dividing the clavicle into equal thirds. Group 1 fractures are those to the middle third of the clavicle, and fractures to the lateral and proximal thirds refer to groups 2 and 3 respectively [28]. It is important to describe the fracture in terms of the degree of displacement, presence of angulation, comminution, and shortening [29]. For proximal or distal fractures, providers need to identify the presence or absence of intraarticular involvement. Describing the angulation of a clavicle fracture generally involves stating the direction of the apex of the angle created by the fracture fragments [30].

See Fig. 2. Minimally displaced midshaft clavicle fracture.

See Fig. 3. Displaced midshaft clavicle fracture with butterfly fragment.

See Fig. 4. Measurement of clavicle fracture shortening.

3.3. History and examination

Assessing a patient with a clavicle fracture starts with the history. Typically, patients will have a traumatic mechanism of injury and complain of localized pain. Patients may report a cracking or snapping sensation experienced with the injury. There are a range of physical exam

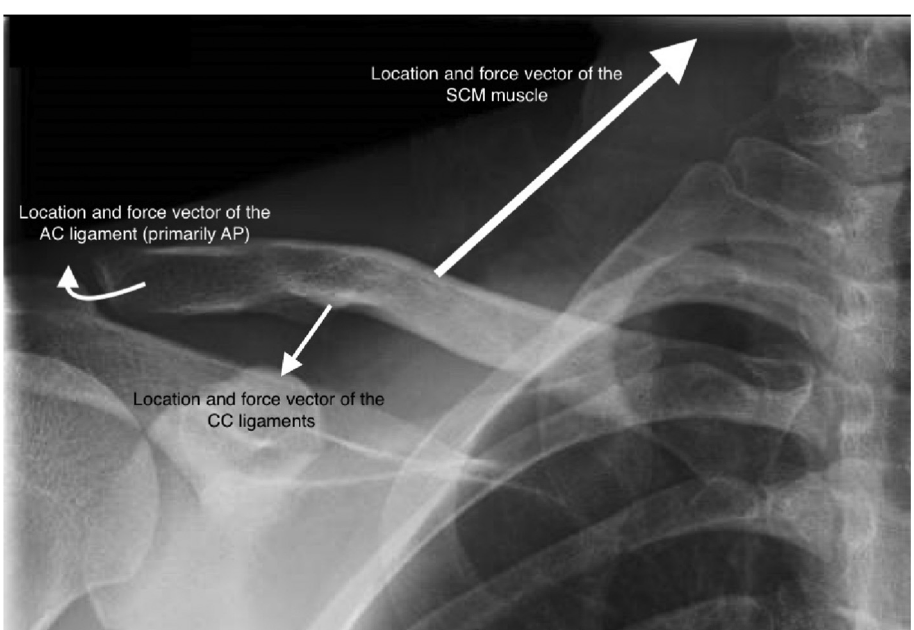

Fig. 1. Clavicle anatomy and forces acting on the clavicle.

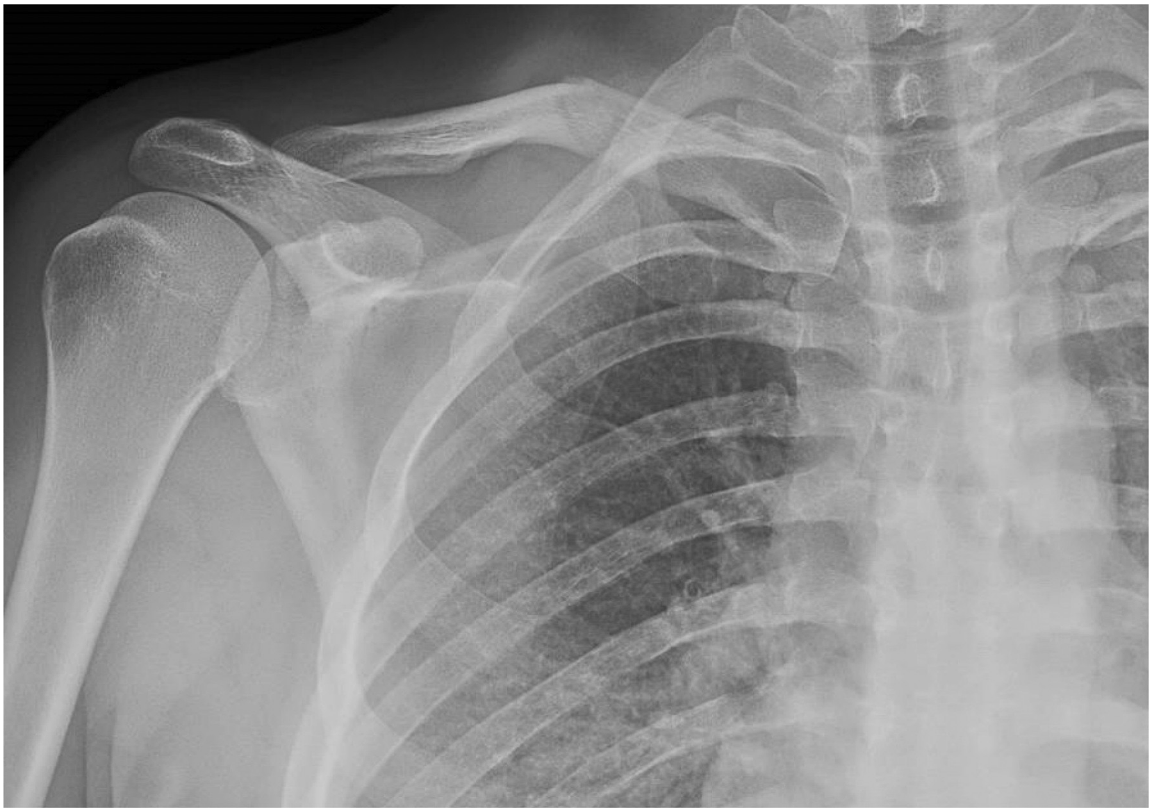

Fig. 2. Minimally displaced midshaft clavicular fracture.

presentations, which include localized swelling and tenderness at the site of injury. With a significantly displaced or angulated clavicle fracture, tenting of the skin may be present, which can portend an increased risk for progression to an open fracture [31]. The proximal portion of the fracture will typically be displaced cephalad due to traction from the sternocleidomastoid (SCM) muscle, while the distal portion of the clavicle may be displaced inferomedial due to the action of the pectoralis major muscle and the downward weight of the arm [32,33].

There are several important anatomical structures adjacent to the clavicle to be aware of during the assessment. The subclavian artery

Fig. 3. Displaced midshaft clavicular fracture with butterfly fragment.

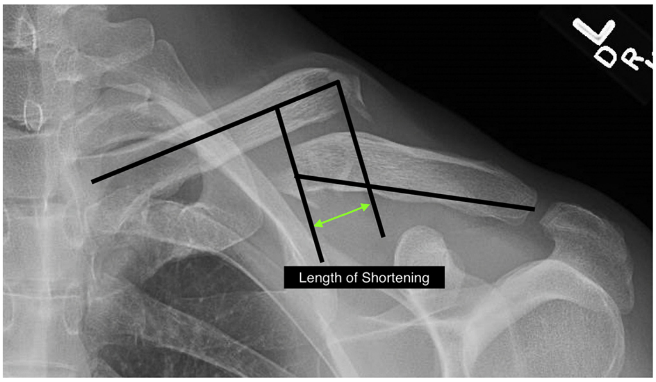

Fig. 4. Measurement of clavicle fracture shortening.

and vein pass underneath the middle third of the clavicle, anterior to the first rib. The brachial plexus runs beneath the clavicle as it enters the upper extremity. Pneumothorax is a rare complication of a clavicle fracture, but the apex of the lung is posterior to the clavicle and can be injured. A thorough neurovascular and pulmonary examination to evaluate for associated injuries is important when a clavicle fracture is suspected or identified. Rib fractures, blunt cerebrovascular injury (BCVI) to the arteries of the neck and base of the skull, hemothorax, tracheal injury, esophageal injury, scapular fracture, and shoulder dislocation are other potential associated injuries [34,35,36,37,38,39,40].

3.4. Imaging

In the ED, a single anteroposterior (AP) or posteroanterior (PA) radiograph of the clavicle is commonly obtained. Dedicated clavicle films with a 20 degree cephalad or caudal tilt to assess for displacement in the anterior-posterior plane can be obtained and may reveal additional displacement that impacts patient management [41,42]. Upright imaging can unmask a significant amount of displacement that can be missed on a supine radiograph. A chest radiograph is helpful to compare both clavicles and is often indicated in these patients to assess for associated injuries [43,44]. Several small studies suggest there may be utility for ultrasound during bedside evaluation of a clavicle fracture [45,46].

For patients with distal clavicle fractures, weight-bearing radiographs (e.g. patient holds a 10 to 15-pound weight in the ipsilateral hand) can be obtained to assess for CC ligament disruption, which impacts surgical decision-making. However, this can be uncomfortable in the acute setting and can also be done in the orthopedic clinic [47].

Before the widespread availability of computed tomography (CT) scanners, the serendipity view radiograph was utilized to evaluate injuries to the SC joint. The serendipity view takes an AP view of the chest and adjusts it to have 40 degrees of cephalic tilt. This makes an anterior SC dislocation appear to be superiorly displaced and a posterior SC dislocation appear to be inferiorly displaced [48]. While multiple review articles cite the superiority of CT over X-ray imaging for the diagnosis of SC joint injuries, the authors could not identify any studies comparing sensitivities of the serendipity radiographs versus CT scan. There are multiple case reports of serendipity view radiographs missing SC dislocations and fractures that were subsequently identified on CT scan [49,50,51,52,53,54,55]. Therefore, and due to the associated injuries discussed below, we agree that CT should be the initial imaging modality for suspected SC joint injuries.

Adding contrast to the CT scan is encouraged to define injuries to structures in the mediastinum due to the significant mechanism involved in most injuries to the proximal clavicle and the high rate of injury to surrounding structures [48,55]. In pediatric studies close to 50% of patients with posterior dislocations of the SC joint had compression of the mediastinum, while only 1 in 8 of the patients had physical examination findings concerning for mediastinal injury. While radiation dosing in our pediatric population is an important consideration, the occult nature of these injuries make CT scans reasonable during evaluation of trauma involving the SC joint [56,57,58].

3.5. Management

Management of clavicle fractures can be operative or nonoperative. Emergency department management and discharge planning will involve pain control as well as supporting the extremity in a brace or sling, regardless of the necessity and urgency of operative intervention.

Emergent surgical referral is required for any open fracture, neurovascular compromise, or skin tenting [59,60]. If there is any break in the skin near a fracture site, assume that it is an open fracture, which requires emergent antibiotics and orthopedic consultation.

3.5.1. Immobilization

In general, clavicle fractures managed nonoperatively require 3–4 weeks of immobilization followed by individualized rehabilitation based on the fracture type [61]. Studies have shown that slings provide adequate initial support for clavicle fractures and do not cause as much skin irritation as figure-of-eight braces [62,63]. Therefore, slings are generally preferred over other bracing modalities. Apply the sling early in the patient's ED course if possible. It is likely the patient will go home in the sling, and this soft tissue rest and support will provide additional symptom relief. Figure-of-eight bracing has utility after reduction of posterior SC joint fractures or dislocations; the brace places torque on the distal segment of the clavicle, which rotates the proximal portion anteriorly on the chest wall and supports the reduction [64,65,66,67,68].

3.5.2. Middle third fractures

Nondisplaced midshaft clavicle fractures are almost universally treated nonoperatively [9,10,11,12,69,70,71]. Surgical indications are based on the degree of displacement, presence of comminution, and shortening of the fracture. Historically, even most displaced midshaft clavicle fractures were managed nonoperatively after studies completed in the 1960's estimated the risk of nonunion at less than 1% [33,72,73,74]. Recent evidence points to higher nonunion rates, lower patient satisfaction, and worse cosmetic results with a nonoperative approach to treating displaced midshaft clavicle fractures [14,21,75,76,77,78,79,80,81]. A randomized controlled trial (RCT) by Ahrens et al. comparing operative versus nonoperative management of 301 patients with displaced midshaft clavicle fractures showed significantly lower rates of nonunion at 9 months in the operative group (0.8% vs 11%) [13]. This is in line with data compiled in another meta-analysis as well as a large retrospective study of over 800 patients, both reporting nonunion rates close to 15% in conservatively treated patients. These studies also demonstrated a significantly shorter time to union in patients treated operatively [20,21].

While nonunion is a radiographic finding, it is also important to consider patient-centered functional outcomes. A group of studies that began in the 1990's implied that shortening of the clavicle after post-fracture healing was of no functional significance [82,83]. More recent data suggests superior functional outcomes from operative fixation. A 2006 retrospective study by McKee et al. found that while range of motion (ROM) was preserved at one year after nonoperative management of displaced midshaft clavicle fractures, strength and endurance were significantly decreased [18]. The RCT by Ahrens et al. also demonstrated superior functional outcomes at 6 weeks and 3 months when measuring disability, performance, and symptoms. Multiple studies and meta-analyses support the assertion that functional outcomes are improved with operative management of significantly displaced or comminuted clavicle fractures [13,84,85,86].

Operative management can also result in expedited return to activity, which can be important to active patients [9,13,16,17,26,87,88]. When looking at the total cost of both operative and nonoperative treatment of displaced midshaft clavicle fractures, Althausen et al. found that patients missed an average of 8.4 days of work in the operative group and 35.2 days of work in the nonoperative group. This led to a significant decrease in the total cost of care in the operatively treated group ($12,977 vs $18,086) [89]. Ultimately, a 2019 Cochrane review on the concluded that there is low-quality evidence on the topic and that the surgeon and patient should consider the benefits and risks of surgery on a patient-by-patient basis [1].

Surgical treatment options for midshaft fractures include both intramedulllary (IM) nailing and plate fixation. Historically the complication rate from plate fixation of clavicle fractures has been high. Most of these complications were related to irritation from the hardware (approximately 80%), but plate fracture, infection, and nonunion also occur. Recent advancements in the plating hardware and surgical technique have decreased those complications, leading to plate removal rates of approximately 5% [90,91,92,93].

IM nailing has become a more popular treatment option for midshaft clavicle fractures in the past decade. It has shown similar positive long-term outcomes, a trend toward lower complication rates, but is less effective in comminuted fractures and may not allow patients to return to full activity as quickly as plating [90,94,95,96].

We recommend an outpatient orthopedic referral in the following situations [1,13,18,87,73,74,7,97]:

- Displaced fractures in high-functioning patients or athletic patients.
- Fractures with greater than 100% displacement.
- Fractures with butterfly fragments or comminution (see Fig. 3).
- Shortening of the clavicle >1.5 cm in high-functioning patients or > 2 cm in any patient.

It is not always straightforward in the ED to know what the recommendations of the orthopedic surgeon will be, and treatment of midshaft clavicle fractures should be adapted to the patient's activity level [7]. We also recommend a referral to orthopedics if the patient has significant concerns about cosmesis. This will allow the patient and the surgeon to make an informed decision based on the patient's goals of care. Knowledge of the benefits and risks associated with surgery should help emergency physicians give patients guidance on the potential treatment options.

3.5.3. Distal third fractures

Distal clavicle fractures are more prone to nonunion than are midshaft fractures, with reported rates of nonunion that range from 28 to 44%. The stability of distal clavicle fractures is based on the fracture's relation to the CC ligaments. Fractures proximal to the CC ligaments tend to be unstable, have higher rates of nonunion, and frequently require operative management. Fractures distal to the CC ligaments are generally stable and treated with conservative care. [98,99,100,101,102]. The high rate of nonunion makes outpatient orthopedic evaluation reasonable for any distal clavicle fracture.

See Fig. 4. Neer classification of distal clavicle fractures.

Classification of distal third clavicle fractures centers around evaluating for possible disruption of the CC ligaments. The Neer Classification is widely used, and it initially described three main types of distal clavicle fractures. Subsequently, type IV (pediatric specific) and type V were added [103]. Type I fractures occur lateral to the CC ligaments but spare the AC joint. Type III fractures also occur distal to the CC ligaments, except that they also involve the AC joint. Intra-articular extension of the fracture raises risk of future AC joint arthropathy [81,105]. Because of the intact CC ligamentous structures (which balance the traction placed on the clavicle by the SCM), both type I and type III fractures are stable and managed nonoperatively.

Type II fractures are potentially unstable because the fracture is proximal to the CC ligaments [104], which leaves the proximal fragment susceptible to superior displacement due to unopposed forces from the SCM. Type IV fractures involve the growth plate in pediatric patients and are discussed in the pediatric distal clavicle fracture section. Type V fractures are functionally similar to type II fractures. They create a small free-floating inferior clavicular fragment that remains attached to the CC ligaments, while the proximal clavicle fragment is susceptible to superior displacement. Type II and Type V distal clavicle fractures have high rates on nonunion, and most authors recommend operative management [2,22,81,105,106,107].

See Fig. 5. Unstable comminuted distal clavicle fracture with disruption of the CC ligaments. (See Fig. 6.)

3.5.4. Proximal third fractures and sternoclavicular joint dislocations

Proximal clavicle fractures are the least common fracture type, but because of the proximity to the mediastinal structures there is a significant risk of life-threatening associated injuries [56,59]. Proximal clavicle fractures and SC joint dislocations are often associated with a severe mechanism of injury. Approximately 90% involve multisystem trauma, and 20% of patients will die within one month of their injuries, usually from associated injuries to the head, neck, chest, or abdominal viscera [56,59]. Therefore, a CT with contrast should be obtained as part of the initial evaluation in all patients with suspected SC injury.

Initial management of isolated nondisplaced proximal clavicle fractures is nonoperative with rest, ice, non-steroidal anti-inflammatory medications (NSAIDs), a sling for support, and activity as tolerated. Healing should occur in 6–8 weeks [48,64,108].

The urgency of referral for displaced fractures depends on several factors. Open fractures should be emergently managed by an orthopedic surgeon. Fractures that have significant anterior displacement (>1 cm) should be given an urgent (1–3 days) orthopedic referral, as these are frequently treated operatively but do not require an emergent procedure [56,59,64].

Posterior displacement of the proximal clavicle (from fracture displacement or SC joint dislocation) can cause impingement of the surrounding vessels or airway obstruction in up to 30% of cases [108]. Signs and symptoms of mediastinal compression include the following: dysphasia, dysphonia, dyspnea, paresthesias, and plethoric upper extremity veins. Failure to reduce a clavicle that impinges on the mediastinum can result in tracheoesophageal fistulas, erosion into the great vessels, thoracic outlet syndrome, or damage to the brachial plexus [64,108,109,110]. Because of these risks, orthopedic consultation is indicated in all posterior displaced fractures and dislocations, for both emergent reduction and because operative stabilization is frequently performed even after successful closed reduction [48,64,59,64,102,108].

3.6. Floating shoulder

Floating shoulder involves a glenoid neck fracture with a concomitant injury to an adjacent bony or ligamentous structure of the superior shoulder girdle (i.e. clavicle, acromion, or AC joint) [18,111]. The term floating shoulder references the consequence of these two structural disruptions, resulting in a lack of bony attachment of the upper extremity to the trunk. This can potentially lead to the humerus pulling the glenoid distally and anteromedially, resulting in long-term dysfunction [112]. Stability of the injury is primarily based on integrity of the coracoclavicular and coracoacromial ligaments along with the AC joint, as all of these structures are important stabilizers of a fractured glenoid neck [113].

Studies have shown that treatment of a floating shoulder can be tailored to the patient, and there are adequate functional outcomes with both appropriate operative and nonoperative management. Operative decision making is generally dependent on the amount of displacement of the glenoid (with 20-25 mm of medial displacement generally being the cutoff) and patency of the surrounding ligaments. For patients meeting the criteria for instability, a discussion about disposition with an orthopedic consultant is reasonable with the expectation that urgent outpatient orthopedic treatment (1–3 days) is a likely course of care [114,115]. Immobilization in a sling with the shoulder in internal rotation is appropriate for injuries that will be managed nonoperatively [116,117,118].

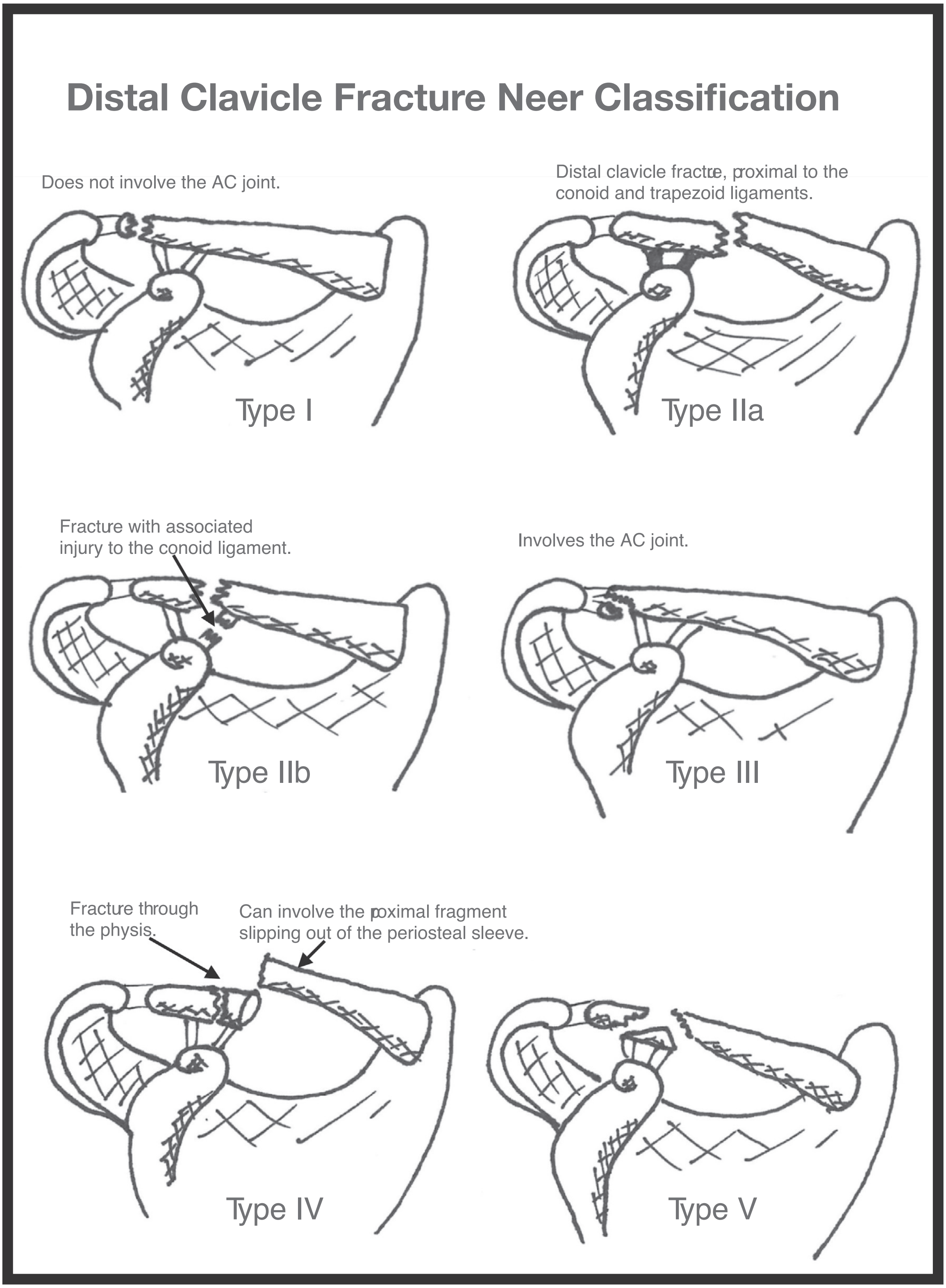

Fig. 5. Neer classification of distal clavicle fractures.

3.7. Pediatric clavicle fractures

Pediatric clavicle fractures are generally managed based on the age of the injured child. For girls <9 years old and boys <12 years old, almost all clavicle fractures are managed nonoperatively [119]. After those age cutoffs, midshaft and distal fractures are managed using algorithms similar to treating adults [33,119,120,121,122]. The exceptions are Neer Type IV fractures, where the fracture involves the growth plate of the distal clavicle. This may allow the fractured bone to slide out of the supporting periosteal sleeve. This fracture can also be

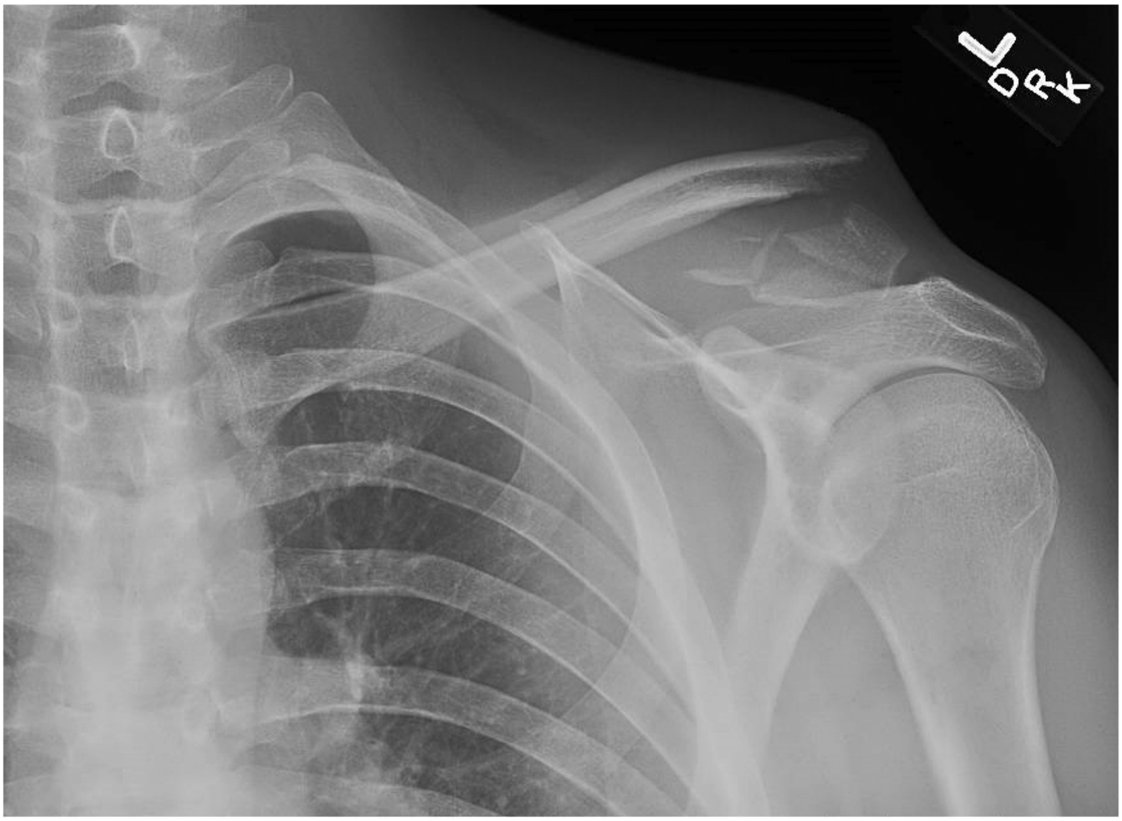

Fig. 6. Unstable comminuted distal clavicle fracture with disruption of the CC ligaments.

mistaken for a type V AC separation, which is an injury that is less common in pediatrics [98,99,100,101,102]. All Neer type IV fractures should be referred to an orthopedic surgeon [18,103,123]. The proximal clavicular physis is the last in the body to close, because of this what appears to be a SC dislocation in a patient up to 25 years old can actually be a fracture through the physis (i.e. a Salter-Harris I or II fracture) [119,120,124,125]. Management of proximal clavicle fractures in children is also similar to adults, with emergent orthopedic referral indicated for posteriorly displaced fractures or dislocations [64,108,126,127].

Historically, midshaft clavicle fractures in adolescents were primarily managed nonoperatively, and most of the fractures achieved bony union with good functional results [33,128,129,130]. Recent studies on adolescents have shown operative treatment results in earlier return to full activity (4–6 weeks instead of 12 weeks with nonoperative treatment), lower rates of nonunion, earlier time to union, preferred long term cosmetic results (e.g. no long-term bony bulge of the shoulder) [19,121,122,131,132,133,134,135]. We recommend referring displaced midshaft clavicle fractures in adolescent patients to an orthopedic surgeon. This will allow the patient and family to have a focused conversation about the potential risks and benefits of operative treatment.

3.8. Pain management strategies

Pain management for acute fractures in the ED often requires a multimodal approach. Acetaminophen, NSAIDs, or oral or parenteral opiate analgesics may be required to obtain adequate pain control, especially if other injuries are present.

In addition to medications, the emergency physician can consider utilizing a hematoma block. The procedure involves an injection of local anesthetic into the periosteum and hematoma that forms at the site of a fracture [136]. This procedure has been described as a safe and effective alternative to intravenous analgesics in the reduction of distal radius fractures in the ED [137,138,139,140]. A similar technique is used in our group for clavicle fractures.

Regional anesthesia is another option. Evidence in the surgical and anesthesia literature shows that the combination of an interscalene brachial plexus block and a superficial cervical plexus (SCP) nerve block leads to safe and adequate anesthesia for operative repair of clavicle fractures [141,142]. The use of the SCP nerve block in isolation has also been described as a technique for acute pain management of clavicle fractures in the ED [143]. The authors use nerve blocks to assist with pain control, especially when patients have long drives home or to provide analgesia for the first night after the injury, so the patient has an easier time sleeping. The duration of the nerve block is dependent on the anesthetic used. Lidocaine with epinephrine has been shown to provide approximately 4 h of analgesia, while longer acting agents like bupivacaine or ropivacaine provide 7–10 h of pain relief [144].

After discharge, most clavicle fractures can be managed with over-the-counter pain medications such as acetaminophen and NSAIDs along with a supportive sling. Recent studies have found equivalent pain control in both adult and pediatric patients treated with NSAIDs with or without additional opiates for extremity injuries, which included fractures [145,146,147,148]. A short course (1–3 days) opiate prescription can be considered on a case-by-case basis, and our practice is to encourage patients to use these medications sparingly and only for sleep if possible.

There is a theoretical risk that NSAIDs impact fracture healing by inhibiting cyclooxygenase (COX); COX has a positive impact on bony remodeling. Studies on NSAIDs' impact on fracture healing have shown no harm for pediatric fractures, distal radius fractures, ankle fractures, or with a short course (<72 h) treatment for long bone fractures. Separate meta-analyses have presented divergent data on if there is an association between long term nonselective NSAID use and long bone nonunion in adult patients. The use of selective COX-2 inhibitors has shown a more consistent negative impact on fracture and soft tissue healing [149,150,151,152,153,154,155,156]. The authors continue to advocate for the use of nonselective NSAIDs as part of a multimodal pain control strategy for clavicle fractures.

3.9. Return to activity

Conservative management of clavicle fractures, such as for nondisplaced or minimally displaced fractures, involves sling immobilization for 4–4 weeks. The steps for return to activity typically involve physical therapy with gradual increase in ROM and strengthening exercises starting at 6 weeks, with full healing around 12 weeks [26,157,158]. After primary operative intervention with IM nail or plate fixation healing includes 2–4 weeks of sling immobilization followed by physical therapy and return to full activity (not including full contact sports) by 6 weeks postoperatively [159,160,161,162,163,164,165].

Weight-bearing activities should be suspended until patients are free of pain and have radiographic evidence of progressing bony union (6–12 weeks). Patients should not return to sports until they have full ROM and strength without pain. Return to work is determined on a patient-by-patient basis depending on the nature of the occupation and details of the injury [61].

Timetables for return to sport are based on the sport the patient is returning to and the fracture pattern [166,167]. In a meta-analysis by Robertson et al., adult patients with nondisplaced midshaft clavicle fractures returned to sports an average of 10.6 weeks after the injury. If the fracture was displaced and managed nonoperatively, return to sports took place in an average of 21.5 weeks. If there was operative management of the displaced fracture the time to return to sport was reduced to 9.4 weeks [168]. With appropriate management, approximately 80% of patients can return to sport at their pre-injury level of activity [166]. Almost all of a patient's ability to return to play at a pre-injury level can be attributed to the functional impact that occurs if the patient develops nonunion or > 2 cm of shortening of the clavicle. A lack of confidence and a concern for reinjury have also been noted as reasons that patients did not return to their previous level of sport [80]. A study of NFL players with clavicle fractures over a five-year period showed similar results. Payers with nondisplaced fractures returned to competition without long-term complications. Players with displaced fractures had high rates of refracture when managed nonoperatively; four out of seven had refracture within one year of the initial injury. For the six players in the study who had operative management of displaced fractures, three were able to return to play the same season [169].

As outlined above, management of midshaft clavicle fractures in pediatric patients has shifted toward operative management. A 2010 study by Vander Have et al. showed return to activity in pediatric patients with displaced midshaft clavicle fractures decreased from 16 weeks in the nonoperative cohort to 12 weeks in the operative group [121]. Other authors now allow return to sport 6 weeks postop in their operatively managed pediatric patients [170].

4. Conclusion

In summary, clavicle fractures are a common injury treated in the ED. An approach to these fractures should involve appropriate imaging, investigation for associated injuries, and immediate pain control. Treatment of the fracture depends on its anatomic location. Midshaft fractures are most common. Distal fractures have the highest rate of nonunion. Proximal fractures have the highest rate of injury to surrounding structures. An outpatient management plan should include multimodal pain control and consideration for orthopedic referral. Nondisplaced fractures in pediatric and adult patients are generally treated nonoperatively. Emergent orthopedic evaluation is indicated for open fractures, posteriorly displaced proximal fractures, SC joint dislocations, and fractures with emergent associated injuries. Urgent referral is warranted for fractures with greater than 100% displacement, shortening of the clavicle > 1.5 cm in high-functioning patients or > 2 cm in any patient, and fractures with butterfly fragments or comminution.

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Declaration of Competing Interest

none.

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